Remote Sensing Instrument for Particulates and NO_X from Heavy-Duty Diesel Vehicles

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New measurement techniques are needed to measure emissions from in-use diesel vehicles. The goal of this project is to develop a portable remote sensing instrument for particulate matter (PM) and gaseous pollutants. Aerodyne Research, Inc., already has developed a dual-wavelength tunable infrared laser absorption instrument for the crossroad remote sensing of CO, NO, and CO_2 for indexing emissions to fuel consumption. This instrument allows for longer range and more sensitive measurements than conventional, nondispersive instruments.

Aerodyne Research, Inc., is developing a remote sensing device for particulate emissions by extending its gaseous pollutant laser instrument designs. This novel approach probes the exhaust plume with several coaligned laser beams that have a range of wavelengths from mid-infrared to visible. All of the beams sample the same absorption path, simultaneously measuring the column density of soot and gaseous pollutants. Multiple wavelength opacity is used to determine the mass density of soot. Multiple wavelengths yield a more precise measurement of opacity, and hence, more accurate soot density. Multiple wavelength measurement also has the potential to distinguish changes in particle characteristics with varying engine state.

During Phase I, both theoretical and experimental investigations were conducted to determine the practicality of multiwavelength opacity measurements for the remote sensing of diesel soot. A prototype instrument that remotely measures opacity at three wavelengths simultaneously with CO_2 at a data rate of 25 Hz was assembled and tested both inside and outside the laboratory, including measurements of plumes of passing automobiles and a diesel fuel pool fire, with highly successful and encouraging results. The instrument demonstrated sufficient sensitivity to measure soot densities at current fleet average emissions from heavy-duty diesel vehicles. Simultaneously, CO_2 was measured with a noise level of 25 ppm-m.

In Phase II, Aerodyne Research, Inc., will build new instrumentation that employs the multiple wavelength particulate system. This instrumentation will be extended to include more wavelengths, and possibly will include scatter information for particle sizing. Quantum cascade lasers will be used for the mid-infrared spectroscopic measurement of gaseous pollutants, allowing for a noncryogenic system. Integrating these techniques into one instrument will provide a powerful tool for survey measurements of both PM and NO_X emissions of heavy-duty diesel engines in real-world situations, with the mix of engine loads encountered in normal driving. Phase II efforts will be conducted in association with a commercial partner that builds remote sensing instruments to detect motor vehicle pollution.

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